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ity within the Dakota to allow passage of the solutions; 4) presence of an impermeable caprock to contain the solutions, which are thought to have risen stratigraphically during their migration northward toward the San Juan Basin or westward toward the Gallup sag; and 5) availability of organic material in the Dakota to reduce and thereby precipitate the uranium from the rising solutions. The author's observations agree with those of Pierson and Green (1980).

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Platinum-group metals in New Mexico

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Introduction

Platinum-group metals (PGM) consist of six elements: platinum (Pt), palladium (Pd), rhodium (Rh), iridium (Ir), osmium (Os), and ruthenium (Ru); platinum and palladium are the most abundant of the group. The PGM typically occur together as natural alloys (for example, osmiridium—an alloy of osmium and iridium) and to a lesser extent as sulfides and arsenides. All the metals are rare (Table 1) and therefore expensive. PGM are used primarily as catalysts in the automotive, chemical, and petroleum-refining industries (U.S. Bureau of Mines, 1987).

Periodically, the NMBMMR is asked to provide information on the occurrence of PGM in the state. More recently, increasing numbers of investors are being approached by speculators to invest in alleged PGM-mining ventures in New Mexico. *NO PGM DEPOSITS ARE CURRENTLY KNOWN IN NEW MEXICO THAT CONTAIN CONCENTRATIONS RICH ENOUGH AND/OR LARGE ENOUGH TO ECONOMICALLY MINE* (Eveleth and Bieberman, 1984) despite numerous claims to the contrary. It is possible that a small amount of PGM could be recovered from the anode slimes produced from a large porphyry copper deposit such as Chino. For example, the concentrates produced by Inspiration Consolidated Copper in Arizona contained a mathematically calculated 0.0000028 troy oz PGM per ton of ore (Phillips, 1980; Eveleth and Bieberman, 1984). There is no documented production of PGM from New Mexico.

Recently the U.S. Geological Survey (USGS) reprinted a map of reported PGM occurrences in the conterminous United States (Blair et al., 1977). That report lists *UNVERIFIED* PGM occurrences in New Mexico as cited in the literature. Not one of those "occurrences" has been found to actually contain PGM.

The purpose of this report is to briefly summarize and evaluate historical reports of PGM occurrences in New Mexico and to consider possible geologic environments in New Mexico that *might* contain undiscovered PGM.

TABLE 1—Abundance of platinum-group metals in crustal rocks (from Greenwood and Earnshaw, 1984).

Element	Symbol	Atomic no.	Abundance (ppm)
Palladium	Pd	46	0.015
Platinum	Pt	78	0.01
Osmium	Os	76	0.005
Iridium	Ir	77	0.001
Ruthenium	Ru	44	0.0001
Rhodium	Rh	45	0.0001

PGM reported in New Mexico
(Blair et al., 1977)

Tampa mine, Bromide district, Rio Arriba County

The Tampa mine in the northern part of the county is one of the largest mines in the Bromide district with a 400-ft shaft and 800–1000 ft of drifts (Bingler, 1968). Sulfide replacement veins containing chalcopyrite, molybdenite, pyrite, malachite, and some free gold occur in schist and granite gneiss of Precambrian age (Lindgren et al., 1910).

"In the Tampa mine, assays frequently show good values in platinum; this is the only place in New Mexico where this rare metal is actually known to exist" (Jones, 1904a). Subsequently, Jones (1904b, 1908, 1915) and Northrop (1959) reported the Tampa mine as a PGM occurrence. However, Lindgren et al. (1910, p. 132) reported that assays of copper ore from the Tampa mine show *NO DETECTABLE PLATINUM*. In fact, L. C. Graton deliberately visited the Tampa mine with the idea of confirming the presence of platinum as reported previously by Jones. He had samples assayed for platinum, something very rarely requested, by Ledoux & Company, probably the best private laboratory at the time, but no platinum was found (Lindgren et al., 1910, p. 132, footnote a).

Red River district, Taos County

The Red River district, near Red River, consists of numerous mines and prospects ranging from Precambrian ore-bearing quartz veins (copper, tungsten, gold, silver, and other ore minerals) to Tertiary ore-bearing veins and disseminated deposits (molybdenite, galena–sphalerite–chalcopyrite, chalcopyrite, galena–sphalerite, and pyrite–gold veins) to Tertiary–Quaternary placer deposits. Mineral deposits occur in Precambrian granite and metamorphic rocks and Tertiary volcanic and intrusive rocks (Schilling, 1960).

In 1910, Fain (1910, p. 3) stated, "there are also indications of . . . sperrylite ($PtAs_2$) . . ." in the Red River district. Northrop (1959) stated, "I know of no subsequent report of this mineral." PGM have yet to be verified from the Red River district.

Ortiz mine, Old Placers district, Santa Fe County

The Ortiz mine is one of the oldest mines in the district. The mine is located on the Cunningham Gulch volcanic vent and follows an irregular gold–quartz vein as much as 4 ft wide and 1 mi long (Lindgren et al., 1910; Elston, 1967). Most of the mining occurred between 1832 and 1870 although several attempts have been made more recently.

Owen and Cox (1865, p. 15) reported an ☞

analysis of gold from the Ortiz mine as containing 99.170% gold, 0.782% silver, and 0.048% iridium. This report is more detailed than most that mention occurrences of PGM in New Mexico; however, no one since has verified the presence of PGM in this district. The assay methods in 1865 were not as accurate as those used today nor was the assay method reported by Owen and Cox (1865). Iridium, along with ruthenium, is the most difficult of the PGM's to determine and this assay is open to question.

Jicarilla district, Lincoln County

The Jicarilla district consists of Tertiary–Quaternary placer deposits, Tertiary vein deposits of pyrite, quartz, copper, gold in monzonite and monzonite porphyry, and skarn deposits of magnetite within the San Andres Formation adjacent to granitic intrusives (Griswold, 1959).

Ellis (1930, p. 60) noted that ". . . platinum and other rare metals are reported from this district . . . ." Northrop (1959) cited Ellis (1930) as the source for listing this district as a PGM occurrence. No other information is available and PGM have never been confirmed as occurring in this district.

Tecolote iron district, Lincoln County, and Tuerto Arroyo, Santa Fe County

PGM were reported to occur in trace amounts in black sand in both areas (Northrop, 1959). Positive identification of PGM has yet to occur. PGM may be confused with magnetite and ilmenite, major constituents of black sand.

Las Animas placers, Hillsboro district, Sierra County

The Las Animas placers consist of gold with limonite and pyrite in alluvial-fan deposits and arroyo deposits derived from the erosion of the Animas Hills (Harley, 1934; Johnson, 1972). The source of the placers is probably gold–pyrite veins in Tertiary andesites.

Jones (1904b, 1908, 1915) and Northrop (1959, pp. 300, 404) reported the occurrence of iridosmine and platiniridium in the Las Animas placers. However, Northrop (1959, p. 404) further stated "its (platiniridium) occurrence here has not been verified by recent workers."

PGM assays by NMBMMR

During the last 25 years, many rock and ore samples have been brought to the NMBMMR for PGM analysis, platinum analysis being the most frequently requested. These samples have come from all portions of the state, but most of them have originated from the Caballo Mountains, Sierra County; the Jicarilla Mountains, Lincoln County; the Cerrillos area, Santa Fe County; the Roswell area, Chaves County; and the Silver City area, Grant County. In cases where the requester was insistent that another lab had confirmed the presence of a PGM, duplicate samples were analyzed by commercial labs known to be familiar with PGM analyses. In addition, some samples from the Stillwater Complex in Montana containing known amounts of platinum and palladium were used as in-house standards to confirm that PGM *could* be detected by standard analytical methods. Selected samples were analyzed by two or more different methods in order to address the question of interferences. The NMBMMR and a number of reputable commercial labs have yet to detect PGM in any New Mexico samples.

Assay Methods for PGM

Early methods used for determining PGM (fire assay, colorimetric, gravimetric) were inexact, subject to interferences, and required that the elements be present in the ppm range for detection. In the 1950's and 1960's, arc emission spectrography was used for determining PGM. However, the iron spectrum possesses strong lines that overlap the weak PGM spectral lines and often result in false positive values for the PGM. Iron, of course, is almost always present in mineralized rock where one would look for PGM. Similar problems are encountered with calcium, which is also, like iron, abundantly distributed in the earth's crust. In the early 1970's, the USGS developed a fire assay method for concentrating and collecting PGM that eliminated iron interference. The bead containing the noble metals was then analyzed by arc emission spectrography. This is an excellent method for determining the concentrations of platinum, palladium, and rhodium and is the one most frequently used by the USGS (Haffty and Riley, 1971). In recent years the arc emission spectrograph has sometimes been replaced by the inductively coupled argon plasma (ICAP or ICP) emission spectrograph. Some labs analyze the fire assay bead by atomic absorption (AA) or neutron activation (NA). But all the labs use a form of fire assay for preconcentration and separation, sometimes with nickel instead of lead as the collector.

Prior to about 1975, platinum and palladium were analyzed at the NMBMMR by gravimetric separation combined with colorimetric determination; this method was very cumbersome and time consuming. After 1975, the NMBMMR analytical lab used the method of Schmepfe and Grimaldi (1969), which consists of preconcentrating platinum and palladium in a gold bead using fire assay techniques followed by atomic absorption analysis to determine PGM concentrations. The detection limit is 0.01 oz/ton (0.33 ppm). Recently, a graphite furnace attachment to our atomic absorption unit extends the detection limit by an order of magnitude. Thus, the NMBMMR can now measure PGM concentrations as low as 0.001 oz/ton (0.03 ppm).

Potentially favorable geologic environments for PGM in New Mexico

Ultramafic and mafic rocks

Many of the world's PGM deposits are in Archean ultramafic and mafic rocks (Page, 1986a, b, c; Eckstrand, 1984). There are no Archean rocks in New Mexico; however, there are a number of localities in the state where Early Proterozoic mafic and, much more rarely, ultramafic rocks occur. Some areas are Pecos greenstone belt, Sangre de Cristo Mountains (Wyman, 1980; Robertson and Moench, 1979); and Tijeras–Hell Canyon greenstone belt, Manzanita–Manzano Mountains (Cavin et al., 1982). Mafic and especially ultramafic rocks in these areas should be examined for PGM.

Alkalic Rocks

Very little information exists on PGM occurrences in alkalic rocks (Mutschler et al., 1985), but PGM values have been obtained from sulfide ores associated with alkalic rock suites in British Columbia, Washington, Montana, and Colorado (Finch et al., 1983). PGM have been recovered from the Palabora carbonatite in South Africa (Mutschler et al., 1985). The presence of detectable PGM in these alkalic and carbonatitic rocks suggests that similar rocks in New Mexico might contain PGM.

Tertiary alkalic rocks occur in the Laughlin Peak area, Colfax County; Sierra Blanca area, Gallinas Mountains, and Carrizozo areas, Lincoln County; and Cornudas Mountains, Otero County. A Proterozoic alkalic complex occurs in Otero County at Pajarito Mountain. Carbonatite dikes are found in the Lemitar and Chupadera Mountains, Socorro County; Monte Largo, Bernalillo County; Lobo Hill, Torrance County; and Laughlin Peak area, Colfax County.

Other geologic environments

The USGS (Zientek et al., 1988) has identified several types of deposits that may contain PGM. Some of them occur in New Mexico and should be examined for their PGM content. These types include organic-rich shale (enriched in Zn, V, Cr, Mo, Ni, Ag, and Se), coal, sediment-hosted copper, carbonate-hosted gold–silver, porphyry copper, gold skarns, low-sulfide gold–quartz veins, basaltic copper, and cobalt (Co, Ag, Ni, As) deposits. As part of ongoing projects at NMBMMR, samples from these deposits will be assayed for PGM. It is interesting to note that *none* of these potentially favorable geologic environments coincide with areas cited on the USGS map or with properties currently promoted on the basis of their PGM content.

Summary

Not one of the reported PGM occurrences in New Mexico (cf. Blair et al., 1977) have been verified as actually containing PGM. Numerous rocks and ore samples from throughout the state have been assayed for PGM with consistently negative results. There are, however, a few geologic environments in New Mexico that may be favorable for PGM occurrences although the likelihood of economic concentrations is small. Detailed geologic and geochemical studies are needed to assess these environments.

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Future

The New Mexico Library of Subsurface Data will continue to incorporate well-completion data, logs, drill cuttings, and other important data into its collections. Present space is sufficient to accommodate log and sample additions for at least five more years. After that time, space limitations may mandate that donations to the cuttings and log collections be accepted selectively.

A plan has been initiated recently to make well-completion and production data available on computer; it will take from eight to ten years to complete digitization of the data. This form of cataloging on computer will allow users of the library to search more efficiently through well records to find the data they need, thereby saving time and effort that can be better devoted to other phases of their projects.

Complementary facilities at NMBMMR

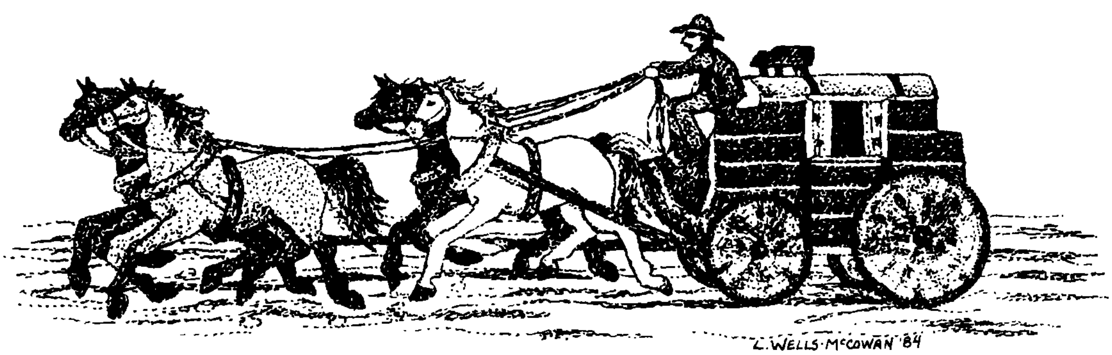
Two additional facilities at the NMBMMR complement the New Mexico Library of Subsurface Data. The Geotechnical Information Center is a repository for records, publications, maps, and other reports pertaining to mines, prospects, mineral industries, and geology of New Mexico. Many documents stored in the Geotechnical Information Center contain information valuable to those exploring for petroleum in the state. The center is managed by Elizabeth Reynolds, (505) 835–5145.

The NMBMMR core library contains numerous drill cores from throughout the state. Although most cores come from holes drilled for mineral prospects, several are from petroleum exploration and development wells. The core library is managed by James Robertson, (505) 835–5125.

Staff and hours

The New Mexico Library of Subsurface Data is manned by three full-time employees of the New Mexico Bureau of Mines and Mineral Resources: Ron Broadhead (Head Petroleum Geologist), Richard Chavez (Assistant Head), and Annabelle Lopez (Petroleum Records Clerk). The full-time staff members are present to process, catalog, and interpret data and to see to the needs of visitors and other clients. Two or three students are employed part-time to process new logs and to wash and process new drill cuttings prior to storage.

The New Mexico Library of Subsurface Data is open Monday through Friday from 8:00 a.m. to 5:00 p.m. The telephone number is (505) 835–5402. □



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